**3GPP TSG-RAN WG2 Meeting #119 electronic bis *R2-XXXXXXX***

**Online, October 10 - 19th, 2022**

**Agenda Item: 8.7.3**

**Source: Thales**

**Title: [AT119bis-e][102][R18 NR-NTN] NW verified UE location (Thales)**

**Work item Rel-18 NR-NTN-enh**

**Document for: Discussion**

# 1 Introduction

This document aims to pursue the discussion around the agenda item 8.7.3 “*Network verified UE location*” before the online session of Thursday 13th October 13:00 (UTC).

* [AT119bis-e][102][R18 NR-NTN] NW verified UE location (Thales)

Initial scope: Continue the discussion on NW verified UE location, based on the report of [Post119][108] and the submitted contributions in AI 8.7.3

Initial intended outcome: Summary of the offline discussion with e.g.:

* + List of proposals for agreement (if any)
  + List of proposals that require online discussions
  + Draft LSs to other groups (if any)

Initial deadline (for companies' feedback): **Thursday 2022-10-13 06:00 UTC**

Initial deadline (for rapporteur's summary in R2-2210841): **Thursday 2022-10-13 08:00 UTC**

The discussion is mainly based on the new contributions of the TSG-RAN WG2 Meeting #119 electronic-bis and the following Post E-mail discussion to decide whether or not companies can agree on some proposals :

* [POST119-e][108][R18 NR-NTN] NW verified UE location (Thales)

Scope: discuss the main principles of the verification procedure (e.g. criteria, performance) and identify potential solutions considering proposals in contributions submitted to RAN2#119-e

Intended outcome: email discussion summary

Deadline: Long

# 2 Context

## 2.1 Recall of TR 38.882 recommendations

The verification should be performed independently from the location information reported by UE.

The UE location information for the study is considered verified if the reported UE location is consistent with the network based assessment to within 5-10 km (similar to terrestrial network macro cell size), enabling country discrimination and selection of an appropriate core network in order to support all the regulatory services (i.e. emergency call, lawful intercept, public warning, charging/billing).

The solution should not impact significantly the latency of the targeted services nor infringe privacy requirements that apply to the UE location.

The study in [RAN2,RAN1,RAN3], which will study and evaluate solutions for the network to verify UE reported location information, shall consider the following aspects:

- The scenario of single satellite (or HAPS) in view by the UE at a time is considered with higher priority.

- Multiple satellite (or HAPS) in view by the UE may be considered if time allows

- Assume that the UE is attached to a network (so that its context has been set up in the network) for the purpose of positioning

- Different solutions or positioning methods for NGSO, GSO or HAPS are not precluded

- When considering solutions based on positioning methods, existing 3GPP defined RAT dependent positioning methods shall be considered as baseline. Other methods are not precluded.

- Solutions using existing NG-RAN architecture and procedures shall be considered

## 2.1 Recall of the previous meeting agreements

### 2.2.1 RAN1#110 agreements

Agreements:

1. The following 3GPP defined RAT dependent positioning methods shall be considered as starting point for the study on Network verified UE location in case of NGSO based NTN deployment:

- Multi-RTT

- DL/UL-TDOA

Note-1: Other methods (e.g. AoA based) are not precluded

Note-2: RAT independent positioning methods are not under the scope of the study

1. For evaluating positioning performance in NTN, the following metrics apply.

• Horizontal accuracy:

- Horizontal accuracy is the difference between a calculated horizontal position by the network and the actual horizontal position of a UE (for evaluation purposes)

- At least CDFs of horizontal positioning errors are used as a performance metrics in NR positioning evaluations

- At least the following percentiles of positioning error is analyzed 50%, 67%, 80%, 90%, 95%

1. The following parameters are assumed for the evaluation of RAT dependent positioning methods study in NTN: *(see Annex 5.1)*

### 2.2.2 RAN2#119-e agreements

Agreements:

1. The UE location information is considered verified if the reported GNSS position is consistent with the network based assessment to within 5-10 km (similar to terrestrial network macro cell size) (it is assumed that there is no RAN2 spec impact due to this)
2. RAN2 should consider, as starting point, the re-use of the LCS framework of the LMF network for the network verification procedure. Send an LS to SA2 indicating RAN2 assumption on this
3. The network verification of the UE reported location may combine one or several 3GPP defined RAT dependent positioning methods (e.g. Multi RTT, DL/UL-TDOA, DL-AoA, NR E-CID, etc.).

LS sent to SA2 (R2-2208779):

“RAN2 is considering the re-use of the LCS framework of the LMF for the network verification of UE reported location information in NTN.

RAN2 would like to inform SA2 about this agreement and ask for any related feedback.”

### 2.2.3 RAN3#117-e agreements

Agreements:

1. The verification is performed in the CN.
2. If the reported UE location is not correct, the CN will take necessary action and Release-17 behavior can be kept as baseline. FFS on new cause value.
3. RAN3 wait for RAN1/2 progress on the specific position method to be used for verification.

## 2.2 List of TDOCs and related proposals submitted to the TSG-RAN WG2 Meeting #119-bis electronic

|  |  |  |
| --- | --- | --- |
| **TDOC** | **Source** | **Observations/Proposals** |
| [**R2-2209407**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209407.zip) | CATT | Observation 1: Both core network and NG-RAN have the requirement of triggering the location verification procedure.  Observation 2: In current LCS architecture, UE or AMF could request for the UE location info from LMF as an LCS client, NG-RAN node functions as an LCS client is not allowed.  Observation 3: For CN triggered location verification procedure, if the verification can be done without GNSS reported by UE, i.e. not limited by the recommendation of 5-10km in TR 38.882, the verification procedure is already supported.  Observation 4: For NR NTN with LEO scenario, TRP(s) should be fixed on satellite, not on ground, the TRP(s) will move together with the satellite(s).  Observation 5: For GEO with multiple satellites, existing RAT-dependent positioning mechanism could be reused well; while for GEO with single satellite case, it seems hard to ensure the required accuracy.  Observation 6: In case of single LEO positioning method, the relative positions between TRPs and UE may affect the positioning accuracy, the parameter need to be evaluated by RAN1.  Clarification on the concept of “trigger verification procedure” and “trigger LCS request”:  Proposal 1: Clarify the concept “trigger verification procedure” refer to the requirement of location verification aroused, not trigger location service request as specified in TS 38.305.  Discussion on the overall verification procedure:  Proposal 2: Both CN triggered location verification and NG-RAN triggered location verification should be supported.  Proposal 3: For location verification, it is only the CN entity allowed to initiate the Location Service Request, NG-RAN function as LCS client is not introduced.  Proposal 4: RAN2 discuss the issue, in case of CN triggered location verification procedure, whether the verification can be done without the GNSS location information reported by UE.  Proposal 5: For NG-RAN triggered location verification procedure, the procedure including following parts:  a) NG-RAN trigger the verification request to AMF, some location related information, e.g. the GNSS reported by UE or ULI, can be carried together;  b) AMF triggers the location service request and completes the positioning;  c) AMF performs the verification and response the verification result to NG-RAN.  Discussion on scenario and positioning methods:  Proposal 6: For NR NTN with LEO scenario, TRP info exchanged between NG-RAN and LMF need to be adjusted due to the moving of the TRPs.  Proposal 7: The study on location verification in scenario of GEO should be postponed until RAN1 evaluate it is feasible.  Proposal 8: For LEO case, the accuracy should evaluate by RAN1, RAN2 can discuss the positioning procedure in parallel.  Proposal 9: RAN2 send an LS to SA3 to ask about the credibility of the reported information, e.g. the position and/or measurements acquired by UE-based/UE assisted positioning methods. |
| [**R2-2209444**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209444.zip) | MediaTek Inc. | Proposal 1: Support solution with multiple-RTT with prediction based on UE-specific TA report.  Proposal 2: If Proposal 1 is agreed then RAN2 should discuss a procedure where the UE is configured to transmit UE-specific TA reports several times for a serving cell over a short period of time immediately after moving to connected. |
| [**R2-2209509**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209509.zip) | vivo | Proposal 1: RAN2 waits for RAN1 progress on the specific 3GPP defined RAT depending positioning method to be adopted for the NW verification purpose. The potential RAN2 enhancement for the positioning method is postponed till RAN1 makes the conclusion  Proposal 2: The verification is performed at the CN. RAN2 waits for SA2/RAN3 input to check if any RAN2 work is needed from the RAN/AS point of view. |
| [**R2-2209579**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209579.zip) | Intel Corporation | Observation 1: in NTN scenario, the beams generated by satellites are in a from-top-to-ground manner, and the RSRP distribution on ground is relatively “flat”. It’s not clear whether E-CID positioning methods can meet the NTN requirements.  Observation 2: in NTN scenario, as all the PHY signals are relayed by the satellite, the AOA/AOD information is common for all UEs in a NTN cell. It’s not clear whether DL-AoA positioning methods can meet the NTN requirements.  Observation 3: in single-satellite NTN scenario, the time interval of PRS transmission for DL-TDOA should be within a proper range, as a long PRS interval can provide higher positioning accuracy, but considering the movement of UE the positioning procedure shouldn’t take a long time.  Observation 4: in single-satellite NTN scenario, the different uplink TA value applied for each SRS transmission should be taken into account in UL-TDOA positioning methods.  Observation 5: In NTN single-satellite scenario, considering the satellite is moving all the time, the time interval between PRS transmission and SRS reception should be within a proper range to meet the positioning accuracy requirement.  And we propose:  Proposal 1: regarding the technical enhancements to positioning methods (e.g., how to adapt them in single-satellite NTN scenario), RAN2 should wait for RAN1 further input. |
| [**R2-2209597**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209597.zip) | THALES | For agreement  Proposal 1: The network shall be able to compute a possible UE location with uncertainty area of 10 km independently from the location information reported by UE.  Proposal 2: The network (5GC) may implement a method to verify the consistency (within 10 km) between the actual reported UE location with a UE location computed by the network. Details on how the CN verifies the UE location is up to SA2.  For further discussion  Proposal 2 bis: FFS whether NG-RAN implements some processing to contribute to the verification of the UE location.  Proposal 3: It is assumed that the verification procedure can be triggered by the CN and it is up to the CN implementation to decide when to trigger the verification procedure. FFS whether NG-RAN can request a verification to the CN.  Proposal 4: RAN2 to prepare an LS to TSG-RAN requesting clarifications on the following TR recommendation “The solution should not impact significantly the latency of the targeted services nor infringe privacy requirements that apply to the UE location.”  Proposal 5: Send a LS to SA3 asking whether an information computed by 3GPP functions and reported by UE can be trusted by the network  Proposal 6: Positioning methods for the verification should prioritize the NGSO case with earth moving and earth fixed beams.  Proposal 7: Multi-connectivity involving multiple transparent NTN NG-RAN nodes or transparent NTN NG-RAN node and TN NG-RAN node is not part of the study for the Release 17-18. |
| [**R2-2209665**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209665.zip) | Huawei, HiSilicon | Proposal 1: It is up to CN implementation when to trigger the verification procedure, which has no impact on RAN2.  Proposal 2: The Multi-RTT and DL/UL-TDOA should be considered with higher priority in RAN2, while waiting for further input from RAN1.  Proposal 3: Before making any decision of what kind of information reported by UE can be trusted by NW, RAN2 should check with SA3 first. |
| [**R2-2209793**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209793.zip) | Apple | Proposal 1: To discuss for PWS message sent via dedicated signaling, whether RAN node is the triggering entity of UE location verification.  Proposal 2: Interested companies should better propose to RAN3 directly on RAN node as verification entity.  Proposal 3: Suggest sending an LS to SA1 and SA2 requesting for latency requirement of UE location verification. |
| [**R2-2209984**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209984.zip) | Spreadtrum Communications | Proposal 1: gNB could trigger AMF to perform the position verified procedure.  Proposal 2: AMF could trigger the position verified procedure itself. |
| [**R2-2210004**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210004.zip) | Lenovo | Observation 1: There may be impacts to the LCS architecture and procedures for network verified location given the nature of NTN deployment, e.g., propagation delays, mobile satellites (with NGSO).  Observation 2: Large latency in NTN with transparent payload may result in inaccurate verification process or may not fulfil the latency requirement of the targeted service.  Observation 3: UE position can be verified by multiple timing advance or differential propagation delay values to its serving cell in different time points.  Proposal 1: RAN2 to confirm that the network verification accuracy requirement is at least in the range between 5-10 km for NTN. FFS whether additional requirements need to be defined for other services, e.g., emergency services.  Proposal 2: The single satellite case has been prioritized based on the conclusions of the TR 38.882, and further study is required regarding the impact to the overall LPP procedures, e.g., the types of positioning methods to perform NTN RAT-dependent positioning to assist in the verification process. RAN1 coordination may be required.  Proposal 3: RAN2 to further study in coordination with SA2 on which the network entities which may trigger, initiate, and perform the network UE location verification procedure, e.g., using the NI-LR LCS procedure. Send LS to SA2.  Proposal 4: RAN2 to support low latency network verification procedures taking into account the extended propagation delays of NTN by considering at least the following:  • Mechanisms to reduce LCS NG-RAN and core network signalling, e.g., identifying the need and benefits of supporting a local LMF in the NTN NG-RAN.  • Identify the frequency of the network verification procedures to avoid unnecessary/redundant triggering of the verification.  • Identify the validity of the provided verified network UE location  Proposal 5: RAN2 to consider RAN-based solutions for UE location verification purposes.  Proposal 6: Study the impact of different multi-connectivity NTN architectures on positioning procedures and verification procedures, e.g., including the use of multi-satellites or TN and NTN connectivity scenario.  Proposal 7: In case of a mixed multi-connectivity scenario involving TN NG-RAN and NTN NG-RAN, the verification procedure does not involve NTN NG-RAN and is based on cell-ID of TN NG-RAN. |
| [**R2-2210096**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210096.zip) | OPPO | Proposal 1 Satellite at a given time is considered as a TRP.  Proposal 2 A moving satellite at multiple time instance is modeled as multiple TRPs.  Proposal 3 TRP’s location is obtained through satellite’s ephemeris information.  Proposal 4 Time difference between satellite-based TRPs should be under network’s control.  Proposal 5 Wait for RAN1 and SA3 to conclude whether TA report can be used for verifying UE location. |
| [**R2-2210120**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210120.zip) | Xiaomi, CAICT | Proposal 1: The above procedure is used as baseline for the UE location verification, including AMF triggers the UE location verification, AMF sends the location request to the LMF, LMF acquires the UE location with essential LPP and/or NRPPa procedure, the LMF sends the UE location to UE and AMF verifies the UE location.  Proposal 2: LMF needs assistance information to select a proper positioning method for UE location verification since only RAT-dependent positioning method should be used.  Proposal 3: How to handle the case when the UE location verification is failure should be addressed by SA2.  Proposal 4: The NG-RAN to verify the UE location can be considered for the RAN selecting the appropriate core network.  Proposal 5: When the solutions are determined by RAN1 and latency requirement of UE location verification are identified by SA2, RAN2 prioritizes the solutions with less specification impact. |
| [**R2-2210242**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210242.zip) | Samsung R&D Institute UK | Observation 1: UE location information based on GNSS/A-GNSS may not be reliable or trusted.  Observation 2: A UE may intentionally provide a fake/misleading location information in the attempt to access a core network different to that where the UE is actually located.  Observation 3: A UE may unintentionally provide an inaccurate location information, e.g. due to inaccuracy in positioning method or uncertainly of location close to country border.  Proposal 1: The network-based location verification solution, at the AMF, uses assistance information from CN to verify UE-generated location information.  Proposal 2: RAN2 to wait for progress in SA2/RAN3 on potential CN-based solution for verification of UE-reported location. |
| [**R2-2210286**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210286.zip) | ZTE Corporation, Sanechips | Observation 1: Fake TA will mislead NW to configure mismatched koffset, which could lead to failed scheduling and at worst service interruption, which is not inline with UE’s interests.  Observation 2: TA based solution is still under assessment in RAN1, it is too early to sent the LS to SA3 to trigger the discussion.  Observation 3: Cell identified assisted UE location verification is an already defined TN NW functionality which can be used in NTN with small update.  Observation 4: Compared to position dependent method it is easier to implement with no risk on privacy concern since the cell identity can be publicly obtained through MIB/SIB1.  Proposal 1: RAN2 consider UE reported TN cell information for NW based UE location verification. |
| [**R2-2210336**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210336.zip) | Nokia, Nokia Shanghai Bell | Observation 1: Ensuring the validity of the UEs reported location should be done by verifying based on a network based position estimate.  Proposal 1: the UE reported location cannot be used in the network-based UE location estimation.  Observation 2: The precision of the network position estimate is based on the quality and/or quantity of the measurements obtained.  Observation 3: The network should have the ability to at least partially control/configure the measurement procedure used for the UE position verification procedure.  Proposal 2: The AMF should be responsible for triggering of more measurements /information to be used for network verified UE location.  Proposal 3: RAN2 to discuss the request procedures for more measurements/information to be used for network verified UE location. |
| [**R2-2210443**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210443.zip) | NTT DOCOMO INC. | Proposal 1. RAN2 should wait for RAN1 evaluation then select appropriate solutions in terms of latency and spec impact from candidate solutions which has enough accuracy.  Proposal 2. It should be confirmed by SA3 case by case whether a certain report from UE can be trusted.  Proposal 3. RAN2 can ask SA3 about UE reports used in candidate solutions even before down-selection.  Proposal 4. Separate solution for each orbit type (NGSO, GSO, HAPS) can be considered, but common solutions should be assumed whichever the NTN-cell is earth-moving or earth-fixed. |
| [**R2-2210509**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210509.zip) | CMCC | Observation 1: in addition to the existing long RTT latency in NTN system, the current LMF-based architecture and procedure which involving CN network and positioning server (LMF) will cost more additional long latency.  Observation 2: current NAS signaling for positioning needs to be adapted into AS signaling for the UE location verification in NTN scenario.  Observation 3: Considering the significant signalling overhead, latency and power consumption, in our understanding, it is feasible and reasonable to limit the network based assessment in the granularity of 5-10 km, which is similar to TN macro cell size.  Proposal 1: existing 3GPP defined RAT dependent positioning methods, e.g., UL/DL TDOA, UL/DL AOA, multi-RTT can be considered as baseline.  Proposal 2: it is propose that RAN2 start to perform the normative work of signalling framework/flow design of RAN based positioning method for the UE location verification in NTN scenario.  Proposal 3: it is proposed to limit the network based assessment in the granularity of 5-10 km, which is similar to TN macro cell size and study the solutions of reporting the TN cell information or Virtual Cell detected by UE.  .Proposal 4: If a given UE is regarded as malicious, as the reported location information is always “fake”, it is reasonable for the gNB to trigger the UE release procedure and recall the resource allocated to the UE.  Proposal 5: the gNB can distribute and share the UE’s credit status according the maintained verification result for the UE to neighbour gNBs or CN. |
| [**R2-2210709**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210709.zip) | Deutsche Telekom, Huawei, HiSilicon | Proposal 1: RAN2 to investigate whether and how the NTN network can instruct the UE to report reference TN PLMN identities for UE location verification.  Proposal 2: RAN2 to take this solution into consideration when evaluating the need for Network verified UE location specification support in Rel-18. |
| [**R2-2210757**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210757.zip) | Ericsson | Proposal 1 Send LS to RAN plenary asking for clarification on the interpretation of TR latency and trust in UE RRC measurements (and if it is actually RRM measurements that is meant instead of RRC measurements). What measurements can be trusted? When and how often does the network need to verify the UE reported location? In case UEs shall be denied service until the UE reported location is verified by the network, what is an acceptable delay for the NW verification procedure?  Proposal 2 Pending answers to latency and trust issues, RAN2 agreements shall state the assumptions. For example, “From a RAN2 point of view, assuming NW may trust the UE reported timing advance using RRC signalling, the NW can estimate the UEs position by receiving N measurements with at least T seconds in between each measurement.” Or “From a RAN2 point of view, assuming UEs can be allowed access to services before the NW has verified the UE location, the latency of the verification is handled by the network.”  Proposal 3 From RAN2 point of view, assuming the NW may allow the UEs access to services before verifying the UE reported location, the latency of the NW verification can be handled by the NW.  Proposal 4 UE reporting of timing advance cannot be trusted in NTNs.  Proposal 5 RAN2 postpone solution discussions for NW verification of UE position until RAN1 have evaluated the solutions. |

# 3 Discussion

## 3.1 Assumptions and principles

The two proposals below come from the Post E-mail discussion [POST119-e][108][R18 NR-NTN] NW verified UE location (see R2-2209597, 4.1 Verification procedure, THALES) . The proposals aim to specify assumptions and principles. Your comments have been taken into consideration. If you agree, these proposals can go for approval at the next online session.

**Proposal 1: RAN2 assumes that the network is able to compute possible UE locations independently from the location information reported by UE.**

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| Company | Agree/Disagree | Remarks |
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**Proposal 2: RAN2 assumes that the network (5GC) is able to verify the consistency (within 10 km) between the actual reported UE location with some of the possible UE locations computed by the network. Details on how the CN verifies the UE location is up to SA2.**

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| Company | Agree/Disagree | Remarks |
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## 3.2 RAN2 studies

This work item is complicated because many subjects depend on other work groups (RAN1-3/SA1-2-3). The blockage comes first from the physical layer difficulties being assessed by RAN1. However, there are two visions proposed in the contributions that you see below:

RAN2 waits for new inputs (especially from RAN1) to start working on the impacts of the verification procedure for the NTN.

Or;

RAN2 starts performing this work with some assumptions that remains to be defined.

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| TDOC | Company | Proposal |
| [**R2-2209407**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209407.zip) | CATT | Proposal 8: For LEO case, the accuracy should evaluate by RAN1, RAN2 can discuss the positioning procedure in parallel. |
| [**R2-2209509**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209509.zip) | vivo | Proposal 1: RAN2 waits for RAN1 progress on the specific 3GPP defined RAT depending positioning method to be adopted for the NW verification purpose. The potential RAN2 enhancement for the positioning method is postponed till RAN1 makes the conclusion |
| [**R2-2209579**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209579.zip) | Intel Corporation | Proposal 1: regarding the technical enhancements to positioning methods (e.g., how to adapt them in single-satellite NTN scenario), RAN2 should wait for RAN1 further input. |
| [**R2-2209665**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209665.zip) | Huawei, HiSilicon | Proposal 2: The Multi-RTT and DL/UL-TDOA should be considered with higher priority in RAN2, while waiting for further input from RAN1. |
| [**R2-2210096**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210096.zip) | OPPO | Proposal 5 Wait for RAN1 and SA3 to conclude whether TA report can be used for verifying UE location. |
| [**R2-2210242**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210242.zip) | Samsung R&D Institute UK | Proposal 2: RAN2 to wait for progress in SA2/RAN3 on potential CN-based solution for verification of UE-reported location. |
| [**R2-2210336**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210336.zip) | Nokia, Nokia Shanghai Bell | Proposal 3: RAN2 to discuss the request procedures for more measurements/information to be used for network verified UE location. |
| [**R2-2210443**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210443.zip) | NTT DOCOMO INC. | Proposal 1. RAN2 should wait for RAN1 evaluation then select appropriate solutions in terms of latency and spec impact from candidate solutions which has enough accuracy. |
| [**R2-2210509**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210509.zip) | CMCC | Proposal 1: existing 3GPP defined RAT dependent positioning methods, e.g., UL/DL TDOA, UL/DL AOA, multi-RTT can be considered as baseline.  Proposal 2: it is propose that RAN2 start to perform the normative work of signalling framework/flow design of RAN based positioning method for the UE location verification in NTN scenario . |
| [**R2-2210757**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210757.zip) | Ericsson | Proposal 2 Pending answers to latency and trust issues, RAN2 agreements shall state the assumptions. For example, “From a RAN2 point of view, assuming NW may trust the UE reported timing advance using RRC signalling, the NW can estimate the UEs position by receiving N measurements with at least T seconds in between each measurement.” Or “From a RAN2 point of view, assuming UEs can be allowed access to services before the NW has verified the UE location, the latency of the verification is handled by the network.”  Proposal 5 RAN2 postpone solution discussions for NW verification of UE position until RAN1 have evaluated the solutions. |

The moderator proposes the following proposals:

**Proposal 3: RAN2 define some assumptions on the positioning methods to study the specification impact in parallel of RAN 1 evaluation.**

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| Company | Agree/Disagree | Remarks |
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**Proposal 4: RAN2 to identify possible signalling impacts (e.g. MAC HEADER, RRC) associated to the combination of one or several 3GPP defined RAT dependent positioning methods to support the network verification of the UE reported location**

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| Company | Agree/Disagree | Remarks |
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## 3.3 NG-RAN roles

Contributions and previous discussions point out that the NG-RAN node can have several roles in the location verification procedure.

The Post E-mail discussion [POST119-e][108][R18 NR-NTN] NW verified UE location (see R2-2209597, 4.1 Verification procedure, THALES) did not fully addressed some cases such as a procedure carried out at the level of the NG-RAN (other than the LCS framework).

In addition, some features have not been discussed so far:

* the gNB can distribute and share the UE’s credit status according to the maintained verification result for the UE to neighbour gNBs or CN. (CMCC)
* PWS (Public Warning System) message sent via dedicated signaling, whether RAN node is the triggering entity of UE location verification (Apple)

Furthermore, some measurements must have a pre-processing by the NG-RAN NTN to be compatible with the NRPPa protocol (between the NG-RAN and the LMF) : for example in the case of a method based on the angle of arrival on a single satellite, the phase difference must be calculated and converted into the appropriate coordinate system.

Consequently, the RAN2 must position itself on their view regarding the role of the NG-RAN.

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| TDOC | Company | Proposal |
| [**R2-2209407**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209407.zip) | CATT | Proposal 2: Both CN triggered location verification and NG-RAN triggered location verification should be supported.  Proposal 3: For location verification, it is only the CN entity allowed to initiate the Location Service Request, NG-RAN function as LCS client is not introduced.  Proposal 4: RAN2 discuss the issue, in case of CN triggered location verification procedure, whether the verification can be done without the GNSS location information reported by UE.  Proposal 5: For NG-RAN triggered location verification procedure, the procedure including following parts:  a) NG-RAN trigger the verification request to AMF, some location related information, e.g. the GNSS reported by UE or ULI, can be carried together;  b) AMF triggers the location service request and completes the positioning;  c) AMF performs the verification and response the verification result to NG-RAN. |
| [**R2-2209793**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209793.zip) | Apple | Proposal 1: To discuss for PWS message sent via dedicated signaling, whether RAN node is the triggering entity of UE location verification. |
| [**R2-2209984**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209984.zip) | Spreadtrum Communications | Proposal 1: gNB could trigger AMF to perform the position verified procedure.  Proposal 2: AMF could trigger the position verified procedure itself. |
| [**R2-2210120**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210120.zip) | Xiaomi, CAICT | Proposal 4: The NG-RAN to verify the UE location can be considered for the RAN selecting the appropriate core network. |
| [**R2-2210509**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210509.zip) | CMCC | Proposal 5: the gNB can distribute and share the UE’s credit status according the maintained verification result for the UE to neighbour gNBs or CN. |

The moderator proposes the following proposals:

**Proposal 5: NG-RAN may implement some processing to support/contribute to the verification of the UE location.**

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| Company | Agree/Disagree | Remarks |
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**Proposal 6: RAN2 to further discuss on whether NG-RAN can also request a UE location verification to the CN (e.g. for PWS).**

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| Company | Agree/Disagree | Remarks |
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## 3.4 Triggering

To clarify, the moderator means by trigger verification procedure, in the context of RAN2, the events that lead the NG-RAN to carry out actions in relation to the verification procedure.

The proposal formulated by the moderator in this part comes from the Post E-mail discussion [POST119-e][108][R18 NR-NTN] NW verified UE location. If you agree, this proposal can go for approval at the next online session.

|  |  |  |
| --- | --- | --- |
| TDOC | Company | Proposal |
| [**R2-2209407**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209407.zip) | CATT | Proposal 1: Clarify the concept “trigger verification procedure” refer to the requirement of location verification aroused, not trigger location service request as specified in TS 38.305.  Proposal 2: Both CN triggered location verification and NG-RAN triggered location verification should be supported. |
| [**R2-2209665**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209665.zip) | Huawei, HiSilicon | Proposal 1: It is up to CN implementation when to trigger the verification procedure, which has no impact on RAN2. |
| [**R2-2210004**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210004.zip) | Lenovo | Proposal 3: RAN2 to further study in coordination with SA2 on which the network entities which may trigger, initiate, and perform the network UE location verification procedure, e.g., using the NI-LR LCS procedure. Send LS to SA2. |

The moderator proposes the following proposals:

**Proposal 7: RAN2 assumes that the UE location verification procedure can be triggered by the CN and it is up to the CN implementation to decide when to trigger the procedure.**

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| Company | Agree/Disagree | Remarks |
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## 3.5 Scenarios

### 3.5.1 Assistant information over time

Some positioning methods require measurement samples over time. In the case of a satellite which is not fixed with respect to the cell it serves, the measurements change and consequently the LMF must adjust the assistant information.

CATT proposes the following proposal:

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| TDOC | Company | Proposal |
| [**R2-2209407**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209407.zip) | CATT | Proposal 6: For NR NTN with LEO scenario, TRP info exchanged between NG-RAN and LMF need to be adjusted due to the moving of the TRPs. |

The moderator retains this issue:

**Proposal 8: RAN2 to further discuss whether the TRP info (e.g. measurements in NRPPa), exchanged between NG-RAN and LMF, need to be updated over time due to satellite motion.**

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| Company | Agree/Disagree | Remarks |
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### 3.5.1 Scenario hypothesis

CATT addressed their concerns about the clarification of the positioning scenarios. Most of the companies want to prioritize the NGSO case with earth moving and earth fixed beams. Therefore, the proposal formulated by the moderator in this part comes from the Post E-mail discussion [POST119-e][108][R18 NR-NTN] NW verified UE location. If you agree, this proposal can go for approval at the next online session.

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| TDOC | Company | Proposal |
| [**R2-2210443**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210443.zip) | NTT DOCOMO INC. | Proposal 4. Separate solution for each orbit type (NGSO, GSO, HAPS) can be considered, but common solutions should be assumed whichever the NTN-cell is earth-moving or earth-fixed. |
| [**R2-2209407**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209407.zip) | CATT | Proposal 7: The study on location verification in scenario of GEO should be postponed until RAN1 evaluate it is feasible. |

**Proposal 9: RAN2 should consider in priority the NGSO case with earth moving and earth fixed beams for the definition of the UE location verification procedure.**

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| --- | --- | --- |
| Company | Agree/Disagree | Remarks |
| Thales | Agree | But Earth moving cells could be down prioritised |
|  |  |  |

### 3.5.2 Multi-connectivity

Lenovo addressed their concerns about the clarification of the multi-connectivity status in this work item. The NTN multi-connectivity support is not part of the release 17 & 18. Therefore, the proposal formulated by the moderator in this part comes from the Post E-mail discussion [POST119-e][108][R18 NR-NTN] NW verified UE location. It only aims to clarify our position. If you agree, this proposal can go for approval at the next online session.

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| --- | --- | --- |
| TDOC | Company | Proposal |
| [**R2-2210004**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210004.zip) | Lenovo | Proposal 6: Study the impact of different multi-connectivity NTN architectures on positioning procedures and verification procedures, e.g., including the use of multi-satellites or TN and NTN connectivity scenario.  Proposal 7: In case of a mixed multi-connectivity scenario involving TN NG-RAN and NTN NG-RAN, the verification procedure does not involve NTN NG-RAN and is based on cell-ID of TN NG-RAN. |

**Proposal 10: Multi-connectivity involving multiple transparent NTN NG-RAN nodes or transparent NTN NG-RAN node and TN NG-RAN node is not part of the Rel-18 study on UE location verification.**

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| Company | Agree/Disagree | Remarks |
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## 3.6 Latency and reliability issues

### 3.6.1 Latency impact

A major point to clarify concerns the latency requirement for the location verification procedure. Indeed, some positioning methods are based on measurement sampling over time. As an order of magnitude, a LEO satellite is visible from 5 to 20 min.

The TR 38.882 is not clear about the requirements *“The solution should not impact significantly the latency of the targeted services nor infringe privacy requirements that apply to the UE location.”*

The discussion of the Post E-mail discussion [POST119-e][108][R18 NR-NTN] NW verified UE location leads to request clarifications to SA1/SA2.

|  |  |  |
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| TDOC | Company | Proposal |
| [**R2-2210757**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210757.zip) | Ericsson | Proposal 1 Send LS to RAN plenary asking for clarification on the interpretation of TR latency and trust in UE RRC measurements (and if it is actually RRM measurements that is meant instead of RRC measurements). What measurements can be trusted? When and how often does the network need to verify the UE reported location? In case UEs shall be denied service until the UE reported location is verified by the network, what is an acceptable delay for the NW verification procedure?  Proposal 3 From RAN2 point of view, assuming the NW may allow the UEs access to services before verifying the UE reported location, the latency of the NW verification can be handled by the NW. |
| [**R2-2210120**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210120.zip) | Xiaomi, CAICT | Proposal 5: When the solutions are determined by RAN1 and latency requirement of UE location verification are identified by SA2, RAN2 prioritizes the solutions with less specification impact. |
| [**R2-2209793**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209793.zip) | Apple | Proposal 3: Suggest sending an LS to SA1 and SA2 requesting for latency requirement of UE location verification. |

**Proposal 11:** **RAN2 to prepare an LS to SA1/SA2 requesting clarifications on the following TR recommendation “The solution should not impact significantly the latency of the targeted services nor infringe privacy requirements that apply to the UE location.”**

* **Is there any constraint on the latency (trigger to result) of the verification procedure?**
* **Can the verification procedure be run independently from the targeted services (e.g. in parallel to prevent any set-up delay)?**

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| --- | --- | --- |
| Company | Agree/Disagree | Remarks |
| Thales | Agree |  |
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### 3.6.2 Reliability of reported UE Information

Another major point to clarify concerns the reliability of reported UE information.

The TR 38.882 [1] recommends considering solution based on positioning methods and existing 3GPP defined RAT dependent positioning methods shall be considered as baseline. Also, the document recommends that the verification should be performed independently from the location information reported by the UE (e.g. GNSS)

The RAT positioning methods are listed in the TS 38.305 [2] in the table 4.3.1-1: Supported versions of UE positioning methods. Some of these methods are UE-assisted.

During the last plenary meeting #96, it was mentioned orally that 3GPP defined functions shall be considered as trustworthy.

It is difficult to make any assumptions if the other working groups reject certain information from the UE due to security issues.

The discussion of the Post E-mail discussion [POST119-e][108][R18 NR-NTN] NW verified UE location leads to request clarifications to SA3.

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| --- | --- | --- |
| TDOC | Company | Proposal |
| [**R2-2209665**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209665.zip) | Huawei, HiSilicon | Proposal 3: Before making any decision of what kind of information reported by UE can be trusted by NW, RAN2 should check with SA3 first. |
| [**R2-2210096**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210096.zip) | OPPO | Proposal 5 Wait for RAN1 and SA3 to conclude whether TA report can be used for verifying UE location. |
| [**R2-2210336**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210336.zip) | Nokia, Nokia Shanghai Bell | Proposal 1: the UE reported location cannot be used in the network-based UE location estimation. |
| [**R2-2210757**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210757.zip) | Ericsson | Proposal 1 Send LS to RAN plenary asking for clarification on the interpretation of TR latency and trust in UE RRC measurements (and if it is actually RRM measurements that is meant instead of RRC measurements). What measurements can be trusted? When and how often does the network need to verify the UE reported location? In case UEs shall be denied service until the UE reported location is verified by the network, what is an acceptable delay for the NW verification procedure?  Proposal 4 UE reporting of timing advance cannot be trusted in NTNs. |
| [**R2-2209407**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209407.zip) | CATT | Proposal 9: RAN2 send an LS to SA3 to ask about the credibility of the reported information, e.g. the position and/or measurements acquired by UE-based/UE assisted positioning methods. |
| [**R2-2210443**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210443.zip) | NTT DOCOMO INC. | Proposal 2. It should be confirmed by SA3 case by case whether a certain report from UE can be trusted.  Proposal 3. RAN2 can ask SA3 about UE reports used in candidate solutions even before down-selection . |

Based on the Post E-mail discussion [POST119-e][108][R18 NR-NTN] NW verified UE location and the previous TDOC list, the moderator proposes the following proposal :

**Proposal 12: RAN2 to prepare an LS to SA3 asking whether an information reported by the UE in the MAC HEADER and/or the RRC protocol can be trusted by the network although derived from GNSS measurements (e.g. UE Specific TA, Doppler shift, Radial satellite velocity etc...)?**

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| --- | --- | --- |
| Company | Agree/Disagree | Remarks |
| Thales | Agree |  |
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## 3.7 Terrestrial Network

This topic suggests using the terrestrial network information to perform the UE location verification.

This discussion has already started in Post E-mail discussion [POST119-e][108][R18 NR-NTN] NW verified UE location.

The moderator (Thales) concluded that most companies consider that the studied solution should be focused on a generic method and that there is no guarantee of terrestrial network availability.

But this approach can still be applied for scenarios where Terrestrial Network is available. ZTE describes in his TDoc the advantages of using this kind of method (see. Obs 3 and 4 in the following table).

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| TDOC | Company | Proposal |
| [**R2-2210286**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210286.zip) | ZTE Corporation, Sanechips | Observation 3: Cell identified assisted UE location verification is an already defined TN NW functionality which can be used in NTN with small update.  Observation 4: Compared to position dependent method it is easier to implement with no risk on privacy concern since the cell identity can be publicly obtained through MIB/SIB1.  Proposal 1: RAN2 consider UE reported TN cell information for NW based UE location verification. |
| [**R2-2210709**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2210709.zip) | Deutsche Telekom, Huawei, HiSilicon | Proposal 1: RAN2 to investigate whether and how the NTN network can instruct the UE to report reference TN PLMN identities for UE location verification.  Proposal 2: RAN2 to take this solution into consideration when evaluating the need for Network verified UE location specification support in Rel-18. |

RAN2 can start evaluating what information can be used, hence the moderator proposes the following proposal:

**Proposal 13: RAN2 evaluates which information related to the NG RAN of Terrestrial Network could be used for UE location verification (e.g. TN cell information, PLMN identities, MCC, MNC) in case of overlapping coverage between TN and NTN.**

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| --- | --- | --- |
| Company | Agree/Disagree | Remarks |
|  |  |  |
|  |  |  |

# 4 References

1. R2-2209597 Summary of POST119-e [108] NW verified UE location (Thales), Thales, RAN2#119e-bis, Electronic, October 2022
2. TR 38.882 Study on requirements and use cases for network verified UE location for Non-Terrestrial-Networks (NTN) in NR, 3GPP, v18.0.
3. R2-2209407 Discussion on UE Location Verification, CATT, RAN2#119e-bis, Electronic, October 2022
4. R2-2209444 On Network Verified UE Location in NR NTN, MediaTek Inc., RAN2#119e-bis, Electronic, October 2022
5. R2-2209509 Discussion on Network verification of UE location in Rel-18 NR NTN, vivo, RAN2#119e-bis, Electronic, October 2022
6. R2-2209579 Discussion on the technical issues of positioning methods in single-satellite NTN, Intel Corporation, RAN2#119e-bis, Electronic, October 2022
7. R2-2209665 Discussion on the network verfied UE location, Huawei, HiSilicon, RAN2#119e-bis, Electronic, October 2022
8. R2-2209793 Discussion on network verified UE location, Apple, RAN2#119e-bis, Electronic, October 2022
9. R2-2209984 Discussion on UE location verify procedure, Spreadtrum Communications, RAN2#119e-bis, Electronic, October 2022
10. R2-2210004 On NTN NW verified UE location aspects, Lenovo, RAN2#119e-bis, Electronic, October 2022
11. R2-2210096 Discussion on network verified UE location, OPPO, RAN2#119e-bis, Electronic, October 2022
12. R2-2210120 Discussion on network verified UE location, Xiaomi, CAICT, RAN2#119e-bis, Electronic, October 2022
13. R2-2210242 Network Verified UE Location, Samsung R&amp;D Institute UK, RAN2#119e-bis, Electronic, October 2022
14. R2-2210286 Consideration on NW verified UE location, ZTE Corporation, Sanechips, RAN2#119e-bis, Electronic, October 2022
15. R2-2210336 On network verified position, Nokia, Nokia Shanghai Bell, RAN2#119e-bis, Electronic, October 2022
16. R2-2210443 Discussion on Network Verified UE Location, NTT DOCOMO INC., RAN2#119e-bis, Electronic, October 2022
17. R2-2210509 Considerations on UE Location Verification via Network, CMCC, RAN2#119e-bis, Electronic, October 2022
18. R2-2210709 UE location verification in NTN, Deutsche Telekom, Huawei, HiSilicon, RAN2#119e-bis, Electronic, October 2022
19. R2-2210757 R18 NR NTN Network verified UE location, Ericsson, RAN2#119e-bis, Electronic, October 2022

# 5 Annex

## 5.1 Parameters for evaluation of RAT

**3GPP TSG RAN meeting #97-e**

**e-meeting, Sept 12 - 16th, 2022**

**RP-222019** *revised RP-221746*

**Status report for WI NR NTN (Non-Terrestrial Networks) enhancements**

**The following parameters are assumed for the evaluation of RAT dependent positioning methods study in NTN:**

|  |  |
| --- | --- |
| **Parameter** | **Description/Value** |
| **Scenarios** | Rural, LOS |
| **Satellite Orbit** | 600km, optional: 1200km |
| **Satellite parameters** | Reuse Set-1satellite parameters as in table 6.1.1.1-1/2 of TR38.821 |
| **Channel model/ Delay spread** | Based on section 6.7.2 of TR 38.811 |
| **FR/Carrier frequency** | FR1: 2GHz, S-band (n256). Optional: FR2 |
| **BW** | To be reported by companies |
| **Subcarrier spacing, kHz** | 15 for FR1, optional: 120 kHz for FR2 |
| **Number of satellite in view** | 1 for single satellite case, |
| **Orbit inclination** | To be reported by companies |
| **UE type** | Handheld terminal, Optional: VSAT |
| **UE related parameters** | Handheld UE characteristics as in Table 6.1.1.1-3 of TR38.821 with update of polarization, Tx/Rx antenna gain, and antenna type and configuration as agreed under AI 9.12.1 |
| **Positioning signals (Note 1)** | To be reported |
| **Reference Signal Physical Structure and Resource Allocation (RE pattern)** | To be reported |
| **RS type of sequence/number of ports** | To be reported |
| **Number of symbols used per occasion** | To be reported |
| **number of occasions used per positioning estimate** | To be reported |
| **Time window for measurement collection** | To be reported |
| **Interference modelling (ideal muting, or other)** | To be reported |
| **Reference Signal Transmission Bandwidth** | To be reported |
| **Reference point for timing measurement** | Satellite |
| **Description of positioning technique / applied positioning algorithm** | To be reported |
| **UE speed** | 3km/h |
| **Maximum timing measurement error** | To be reported |
| **Performance metrics** | Horizontal accuracy (UE 2D position accuracy) |
| **Additional notes, if any** | Note 1: Time-related measurements can be performed via other downlink and uplink signals than PRS and SRS    Note 2: The corresponding link budget should also be reported and the verification procedure should be done within the restriction of minimum elevation angle for service, e.g., 30 degree for LEO |

# 6 Contact information

|  |  |
| --- | --- |
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